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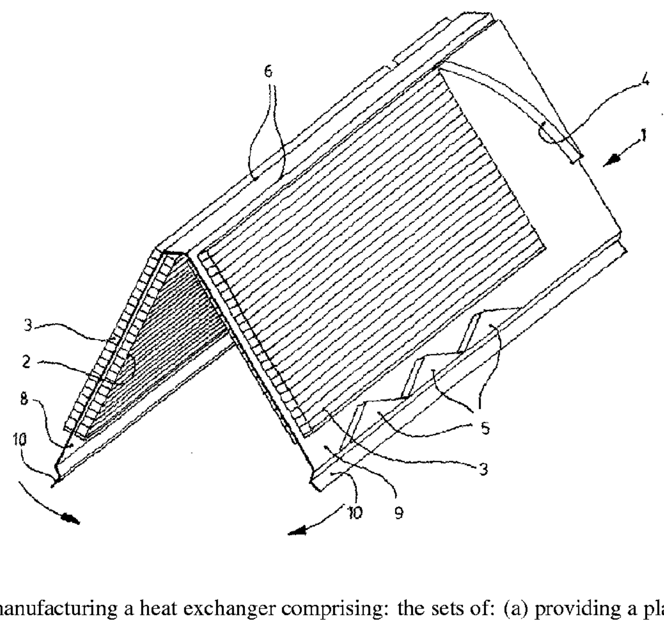
(54) **Title:** A METHOD FOR MANUFACTURING A HEAT EXCHANGER, AND HEAT EXCHANGER OBTAINED WITH THAT METHOD



(57) **Abstract:** Method of manufacturing a heat exchanger comprising: the sets of: (a) providing a plastically deformable plate (1) ; (b) providing a row of fins (2) ; (c) plastically deforming the plate (1)such that it acquires an edge zone (10)with which it can be connected to a similar plate; (d) connecting the fins (2) to the plate (1) ; (e) successively repeating steps (a), (b), (c) and (d) to obtain a number of heat-conducting walls with fins; (f) connecting these walls in twos to each other with the edge zones; and (g) accommodating these walls in a housing with primary and secondary inlets and outlets for the respective media.

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METHOD OF MANUFACTURING A HEAT EXCHANGER, AND HEAT EXCHANGER OBTAINED WITH SAID METHOD

The invention relates to a method of manufacturing a heat exchanger, comprising:

two sets of medium through-flow channels placed mutually interlaced, which sets of channels form respectively a primary medium circuit and a secondary medium circuit, through which two medium flows can flow which are physically separated and in heat-exchanging contact;

heat-conducting walls separating said channels; and

a housing in which the walls bounding the channels are accommodated, to which housing connect two inlets and two outlets for the two sets of channels.

It is an object of the invention to provide a method of manufacturing a heat exchanger which can be performed very inexpensively, rapidly and with great reliability, so that the heat exchangers can be manufactured, also in mass production, at considerably reduced cost compared to the prior art.

In respect of the above stated objectives, the invention provides a method of manufacturing the specified heat exchanger, which method comprises the following steps, to be performed in suitable sequence, of:

(a) providing a plastically deformable plate, for instance of a plastic or a metal such as copper or aluminium;

(b) providing at least one metal strip modelled into a general wave shape, for instance of copper or aluminium, which can serve as a row of fins;

(c) plastically deforming the plate such that it acquires an edge zone with which it can be connected to a similar plate;

(d) prior to or after step (c), connecting the strip to the plastically deformable plate by means of the outermost surfaces of the wave shape directed toward

the strip such that a heat-conducting wall with heat-conducting fins is created;

(e) repeating steps (a), (b), (c) and (d) a number of times to obtain a number of heat-conducting walls with fins;

(f) connecting these walls at least in twos to each other using the edge zones according to step (c) such that a chosen number of such walls is placed in mutually parallel relation; and

(g) accommodating these walls in a housing with primary and secondary inlets and outlets for the respective media.

The plastic deformation can be carried out in any appropriate manner, wherein the choice is determined partly by the nature and type of the applied material. Use can for instance be made of pressing, thermo-forming, vacuum-forming, injection moulding.

Particularly in the important case that aluminium is applied, the method can advantageously be embodied such that the plastic deformation according to step (c) takes place in cold state.

The method can for instance be embodied such that the plate and/or the fins are provided prior to step (d) with an adhesive layer, and that step (d) is performed by pressing the plate and the fins against each other at least at the position of the contact surfaces, optionally while heating.

A simple press tool can for instance be used for this purpose which provides the necessary adhesion through pressure and optional heating for a certain time. It must be ensured that the heat resistance represented by the adhesive layer lies below a predetermined value. This means that the adhesive layer, given its heat-conducting properties, may have only a limited thickness after forming of the connection.

Great advantages are provided by the method in which the adhesive layer substantially covers the plate and/or the fins completely and protects them against corrosion. The adhesive layer hereby fulfils an adhesive and an anti-corrosive function.

The method can for instance be embodied such that the adhesive layer is applied as foil.

Particularly when a thermoplastic plastic is applied as material for the plastically deformable plate, the method can be embodied such that the adhesive layer is formed together with the plate by co-extrusion into a laminated co-extrudate.

An important variant of the method has the special feature that the plate and/or the fins consist of a material to which the adhesive layer adheres with difficulty, for instance aluminium, and that the part of the adhesive layer directed to the aluminium is adhered thereto via a layer of primer.

The primer layer provides an excellent adhesion of the adhesive layer to the aluminium. Without the primer this adhesion would leave something to be desired, which cannot be permitted in respect of the reliability of the heat exchanger.

The latter specified method can advantageously be embodied such that the primer has a chosen colour, pattern and/or texture, and that the adhesive layer is transparent. The primer can for instance be gold-coloured. A heat exchanger plate hereby acquires an extremely attractive appearance. Colour, pattern and/or texture can also serve as coding for heat exchanger components, with an eye to ready identification of the category within the selection of technical specifications.

In yet another embodiment the method has the special feature that the primer and/or the coating contain silver, such that the adhesive layer has an anti-microbial action. This embodiment has the great advantage of not requiring any specific provisions in respect of for instance bacterial contamination.

According to yet another aspect of the invention, the method has the special feature that finished plates with fins are adhered to each other in alternate pairs using edge zones, and that a number of thus formed pairs are stacked onto each other prior to step (g). The finished plates or walls can for instance be identical.

The latter embodiment of the method can particularly take place such that adhesion takes place by providing the plates in advance with the adhesive layer and pressing the edge zones against each other, optionally while heating. This method can also be performed in exceptionally simple, inexpensive and rapid manner.

This latter described method can further be embodied such that the plates are adhered to each other via a sheet which is placed beforehand therebetween and which is provided on both sides with an adhesive layer, and that the respective edge zones directed toward each other and preferably also the respective outer surfaces of the fins directed toward each other are thus adhered to each other by being pressed together, optionally while applying heat, for instance by feeding through hot air.

The invention further relates to a heat exchanger obtained by applying any of the above described specifications.

A heat exchanger can for instance have the special feature that the walls are arranged in at least one group of at least two walls, wherein a group is formed from an integral sheet which comprises at least a layer of plastic and which is brought into a preselected form by pressing, thermo-forming, vacuum-forming, injection moulding or other modelling process and is provided with a hinge zone in the transition between two adjacent walls, wherein by folding about the hinge zone the two walls are then placed into substantially mutually parallel relation and at a chosen mutual distance, and are held by positioning means.

In the simplest embodiment there are two walls held at a mutual distance which, in a generally U-shaped relation, together bound a primary or secondary medium through-flow circuit, wherein the outer side of the U also bounds respective secondary or primary medium channels. This is however only a very simple embodiment.

The invention is particularly suitable for mass production with very easily adjustable dimensioning, since there is in principle a completely free choice of

the number of channels. There is then a concertina-like or zigzag structure which can extend in principle over an unlimited number of channels.

Said positioning means can be embodied in any appropriate manner. Use can for instance be made of snap connections, glue connections, welded joints, folded seam connections, hook connections etc., optionally in combination with spacers. A condition in all circumstances is that the secondary and the primary medium flow are substantially separated from each other physically.

In a specific embodiment the heat exchanger has the feature that a hinge zone consists of two hinge lines which are located at said mutual distance. The hinge lines can each consist of a line of smaller thickness, such as in the form of a film hinge, a score, a wave structure or any other suitable structure. A perforated line will in general be less suitable because of the desired separation between the two medium flows.

In another embodiment the heat exchanger has the feature that a hinge zone comprises two parts which form part of the respective walls and are folded at substantially 90°, which parts are mutually connected by a hinge line.

A considerable improvement in the efficiency of the heat exchanger can be realized with an embodiment having the special feature that heat-conducting fins or surface area-increasing means are arranged, prior to folding, on both sides of the sheet in the zones of the walls in order to increase the heat transfer between the two media. The fins, which can also be embodied for instance as pins, generally surface area-increasing provisions, must have a good heat conduction, be manufactured for instance from a suitable material such as copper, aluminium, carbon or the like.

In a particular embodiment the heat exchanger has the feature that heat-conducting fins are arranged, prior to folding, on both sides of the sheet in the zones of the walls in order to increase the heat transfer between the two media. The mechanical co-action can be brought about by adhesion, such as by glueing,

soldering, welding or by pressing. The walls with the fins can for instance be accommodated close-fittingly in the housing.

In order to improve the heat-exchanging contact via the wall, the heat exchanger can have the feature in a particular embodiment that the sheet is provided in the zone of the wall with a perforation, to the edges of which the heat-conducting wall parts carrying the fins are sealingly adhered. The relevant wall parts can be provided with a heat-conducting material, for instance a metal such as copper or aluminium, or also be embodied in a heat-conducting plastic, for instance a plastic including carbon, aluminium powder or the like. The drawback of this structure is that the manufacture of the heat exchanger requires an additional step. The advantage is that the performance can be superior and, when metal wall parts are used, the construction can have an increased robustness.

The heat exchanger can advantageously have the special feature that the inlet zone and/or the outlet zone of a channel is provided with a deflection dam which deflects the relevant medium flow to the inlet or from the outlet.

The modelling process, for instance vacuum-forming or thermo-forming, lends itself very well to the manufacture of a sheet of the described specification. Other provisions, such as water outlets and the like, can also be arranged in this way.

In yet another embodiment the heat exchanger has the special feature that at least the fins in the secondary medium through-flow circuit are provided with a hydrophilic and porous or fibrous coating, consisting for instance of a microporous Portland cement, which layer is kept wet by watering means forming part of the heat exchanger such that, through evaporation therefrom by the secondary medium, respectively the layer, the secondary fins, the wall, the primary fins and finally the primary medium are cooled, which layer has a small thickness such that in wet state it has a sufficiently low heat resistance such that the heat exchanger can operate as dewpoint cooler.

In order to obtain a good mechanical strength, corrosion resistance and heat transfer in combination with relatively low cost, the heat exchanger can have the special feature that the sheet is embodied as a laminate, comprising a metal inner layer which is coated on both sides with plastic outer layers. The inner layer can for instance consist of aluminium with a thickness in the order of magnitude of 25 μm. The plastic outer layers, which can consist of any suitable plastic, can for instance also have a thickness in the order of magnitude of 25 μm. With such a small thickness the heat resistance represented by the plastic outer layers is negligible.

According to another aspect of the invention, the heat exchanger can have the special feature that two sheets are each folded into the form of a rectangular wave shape, wherein the two wave shapes have equal pitch, and are positioned mutually interlaced with a relative longitudinal orientation of 90°.

The invention will now be elucidated with reference to the annexed drawings. Herein:

Fig. 1a shows a perspective view of a plastic sheet modelled by thermo-forming, on both sides of which heat-conducting fins are arranged;

Fig. 1b shows the phase in which the sheet is folded along the two fold lines such that the walls are moved toward each other;

Fig. 1c shows the end position in which the two walls are positioned fixedly in mutually parallel relation;

Fig. 2a, 2b and 2c show views corresponding to respectively fig. 1a, 1b and 1c of an embodiment with the same width but of greater length;

Fig. 3a shows a perspective view of a sheet having in the zone of the walls rectangular perforations for passage of fins;

Fig. 3b shows a perspective view of a heat-conducting wall, on both sides of which fins are arranged which fit into the perforations of the sheet according to Fig. 3a;

Fig. 4 shows a partly broken-away perspective view of a heat exchanger, wherein the housing is omitted for the sake of clarity;

Fig. 5a and 5b show perspective views from different sides of a dewpoint cooler;

Fig. 6 is a perspective view of a part of a dewpoint cooler;

Fig. 7 shows a view corresponding with Fig. 4 of a variant;

Fig. 8 is a cut-away perspective view of an alternative of the embodiment of Fig. 3a and 3b;

Fig. 9 shows a schematic perspective view of a heat exchanger constructed from two sheets folded in mutually interlaced manner;

Fig. 10a shows a very schematic view of a compression mould for modelling a plate into a heat-exchanging wall;

Fig. 10b shows a very schematic view of the arranging of strips of fins on either side of the wall;

Fig. 10c shows the heat-exchanging wall having heat-conducting fins arranged thereon;

Fig. 10d shows the stacking of four such walls with fins in order to form the interior of a heat exchanger according to the invention;

Fig. 11 shows an alternative, wherein the heat-exchanging walls and also fins are adhered to each other by means of an adhesive foil;

Fig. 12 is a schematic perspective partial view of a practical embodiment of a strip of fins; and

Fig. 13 is a perspective view of a modelled plastic wall.

Fig. 1 shows a modelled sheet 1 consisting of a thin foil-like material of for instance polystyrene, PVC or PET. It is possible using such materials to apply a relatively small wall thickness, for instance in the order of 0.1 mm. Inexpensive production with a short throughput time is possible with for instance thermo-forming.

Sheet 1 is provided on both sides with schematically indicated packets of fins which, in Fig. 1, are designated 2 for the primary medium through-flow

circuit and 3 for the secondary medium through-flow circuit.

Attention is drawn to the fact that the fins 2, 3 are shown very schematically. They consist in this embodiment of strips of limited length modelled in zigzag form in the longitudinal direction, i.e. the medium flow direction. This aspect is however not significant for the present invention.

Deflection dams 4 are formed in sheet 1 for deflecting the relevant medium flow. This aspect will be further elucidated with reference to Fig. 4.

Sheet 1 further has a number of condensation outlets in the form of funnel-shaped structures with triangular intermediate forms 5 for draining water. This may for instance be condensation water, although in the case of operation of the heat exchanger as dewpoint cooler it may also be excess water added to the secondary medium circuit.

As will be apparent from comparing the three successive steps of Fig. 1a, 1b and 1c, the walls 8, 9 are folded toward each other along hinge lines 6 and 7 to form the folded-up situation shown in Fig. 1c. The construction obtained here is an element of a packet of such elements together forming a heat exchanger. Reference can for instance be made in this respect to Fig. 4, 5a, 6 and 7.

The heat exchanger can also serve for instance as dewpoint cooler. As described above, an effective, for instance intermittent watering of the heat-exchanging surface in the secondary medium circuit must in that case be ensured. This implies that fins 3 must be provided with a coating which has a hydrophilic character and which exhibits an open porosity or fibrous structure such that a rapid distribution of water or other evaporable liquid can occur through capillary suction. The manner in which this watering takes place falls outside the scope of the present invention and will therefore not be discussed further. Fig. 5a shows this watering symbolically.

During this production phase, in which the fins are already arranged, sheet 1 according to Fig. 1a is

treated by at least wetting the fins, in any case on their outer side, and by then applying a mortar in powder form to the fins by atomization. The thus obtained coating of microporous Portland cement can have a thickness in the order of for instance 50 μm. The process in question is highly controllable and produces a hydrophilic and water-buffering coating. The fins 2 in the primary circuit are not provided with such a coating, since no evaporation occurs in the primary circuit.

The free edges 10 of wall parts 8, 9 are carried toward each other as according to Fig. 1b and connected to each other as according to Fig. 1c, for instance by glueing, welding or the like. It will be apparent that a sealing primary medium channel is obtained in this manner. For sealing of a secondary medium channel in which the fins 3 extend other provisions are necessary, in particular sealing means co-acting with a housing.

Fig. 2a, 2b and 2c show structures the same as those according to Fig. 1a, 1b and 1c, with the understanding that the length in the medium flow direction is greater. It is noted here that the medium flow direction extends in the direction of the drawn lines of fins 3. The sheet is designated in Fig. 2 with reference numeral 11.

Fig. 3a shows a sheet 21, the general structure of which corresponds with that of sheet 1 of Fig. 1. Sheet 21 is not however provided with fins 2, 3, but is provided instead with two perforations 22, 23. Into these perforations fit fins 24 which are arranged on a heat-conducting wall 25, for instance by welding or soldering. The fins as well as the wall can be manufactured from for instance copper. Fins designated with 26 are likewise situated on the other side of the wall. The respective blocks of fins fit into perforations 22, 23. The heat-conducting wall part 25 is adhered sealingly to plate 21, for instance by glueing. The finally obtained structure has the same external structure as shown in Fig. 1a. The structure differs from that in Fig. 1a in that the plate or wall part 25 extends on the underside of sheet 1. It is of course

necessary to take into account that wall part 25 must bend readily along hinge lines 6.

It is further noted in respect of Fig. 3b that fins 26 are shown with contour lines only for the sake of clarity. They are of course not visible in this perspective view.

Fig. 4 shows the interior 31, i.e. without a housing or casing, of a dewpoint cooler with the fins omitted. A number of units 32, comparable to the unit of Fig. 1c, are placed in a base 33. As described briefly above, water can be drained via water outlets 34 via an opening 35 in base 33.

Fig. 5a and 5b each show a dewpoint cooler 41 with two units 42, 43. As shown in Fig. 5b, a primary medium flow 44 is admitted to the inside from the one side. On the other side a part of this primary flow, designated 45, exits to the outside. Another part 46 is reversed as partial flow and passes over the watered fins 47. The thus wetted secondary airflow 48 is deflected upward by deflection dams 49 and leaves unit 41 from the top side.

Fig. 6 shows a base in the form of a tray 51 in which a number of units 52 are disposed. Use is also made in this embodiment of deflection dams 53. Fins are not drawn. The openings between funnels 54 give access to the bottom of the tray for water drainage via outlet opening 55.

Fig. 7 shows a structure related to that of Fig. 4. Units 61 have a differently modelled drainage provision.

Fig. 8 shows two units 71 based on the principles elucidated with reference to Fig. 3a and 3b. A copper plate or foil 72 bears on both sides fins which are ordered in respective blocks 73, 74, 75. Identical fins are situated on the non-visible side. These fit as according to an arrow 176 through respective openings 76, 77, 78 in preformed sheet 79. Similarly to the structure shown in Fig. 1c, the walls are folded in the upper hinge zone into a mutually parallel relation, whereafter the free edges 10 are adhered to each other. At variance with the structure of Fig. 1, use is made in this embodiment of a single hinge line 80 which is embodied as a score with a substantially rigid zone on

either side such that, also due to the correspondingly formed co-acting lower wall parts 83, 84, the final mutual distance of walls 81, 82 corresponds with the chosen distance.

This distance can for instance be chosen such that the fins press against each other. By means of a suitable pressing construction it is possible to hereby achieve that units 71 (of which there can be more than two) form a mechanically substantially rigid packet. The fins thus make an essential contribution toward the mechanical strength of the finally obtained heat exchanger.

Fig. 9 shows an alternative embodiment of the heat exchanger according to the invention. Heat exchanger 90 comprises two sheets 91, 92 which are each folded in the form of respective rectangular wave shapes of identical pitch or wavelength. Sheets 91, 92 are positioned mutually interlaced with a relative longitudinal orientation of 90°. The manifolds necessary for feeding and discharging the primary and secondary medium flow are omitted from this schematic drawing. Heat exchanger 90 comprises fins, all designated with 93.

As in the embodiment of Fig. 3, in the embodiment of Fig. 9 the heat exchanger 90 can advantageously be embodied such that fins 93 are in heat-exchanging contact with each other via respective holes in sheets 91, 92, for instance via heat-conducting carrier plates 94. This avoids the heat resistance via the two sheets 91, 92 becoming disturbingly manifest at the location of the fins. Fins 93 and carrier plates 94 must in that case be in the most direct possible thermal contact with each other, for instance by means of a heat-conducting glue layer (for instance a thin pressure-sensitive or thermally activated plastic glue layer), a welding operation, a soldering operation, a mechanical coupling or the like.

Fig. 10a shows an opened mould consisting of a lower mould part 101 and an upper mould part 102 which corresponds therewith and which can be closed as according to arrow 103 to cause plastic cold deformation

of an aluminium plate 104, which is covered on both sides with a glue layer activated by heat and pressure.

Fig. 10b shows that a strip of fins 106, 107 is positioned from both sides on the thus formed, modelled heat-exchanging wall 105 and then pressed on as according to arrows 108, 109 respectively.

Fig. 10c shows wall 105 with the strips of fins 106, 107 arranged thereon. It is noted that the lower surfaces 209 of fins 107 and the upper surfaces 110 of fins 106 are preferably also provided with a glue layer activated by heat and pressure.

Fig. 10d shows the manner in which a number of identical heat-exchanging walls 105 with fins 106, 107 arranged thereon can be coupled to each other to form the interior of a heat exchanger, which must later also be placed in a suitable housing having inlets and outlets for the primary and the secondary medium, as well as associated manifolds, whereby said inlets and outlets can be coupled in the correct manner to the diverse channels in heat exchanger unit 111 of Fig. 10d.

Fig. 11 shows an alternative in which an adhesive foil 112 is placed between two finished walls with fins, whereafter, by suitably pressing together the edge zones 113 with foil 112 therebetween as according to arrows 114 and by pressing the fins 107 against each other with foil 112 therebetween as according to arrows 115, a mechanically very strong structure is created which, owing to the tensively strong connection between walls 105 via adhesive foil 112, is able to withstand an increased internal pressure in the relevant heat-exchanging medium. A very effective manner of causing the adhesive foil 112 to melt under some pressure is to feed hot air through the space occupied by fins 107. The desired softening and, after cooling, the desired adhesion is hereby realized in a short time. The adhesive foil layer 112 is manufactured from a plastic having a relatively low softening and melting point.

Fig. 12 shows schematically the general wave shape suitable for manufacturing a strip of fins, for instance of copper or aluminium. The fins can for instance be embodied as a laminate consisting of a base strip of

copper or aluminium, a layer of primer applied thereto and an anti-corrosive adhesive layer applied thereover which is activated by heat and pressure for coupling of the strip of fins 215 to a wall 105.

Finally, Fig. 13 shows a plastic heat-exchanging wall 116 with relatively shallow stiffening profiles 117 on both short sides, in addition to bent edges 118 with end flanges 119, which bent edges 118 can act as reflection dams. It is noted in this respect that it is unnecessary in most applications to make use of the smooth rounded form of reflection dams as shown for instance in Fig. 1a. The flows of the media are generally steady such that there need be no fear of undesired rheological phenomena.

The heat-exchanging wall 116 of Fig. 13 is symmetrical. This not essential in all circumstances.

CLAIMS

1. Method of manufacturing a heat exchanger, comprising:

two sets of medium through-flow channels placed mutually interlaced, which sets of channels form respectively a primary medium circuit and a secondary medium circuit, through which two medium flows can flow which are physically separated and in heat-exchanging contact;

heat-conducting walls separating said channels; and

a housing in which the walls bounding the channels are accommodated, to which housing connect two inlets and two outlets for the two sets of channels,

which method comprises the following steps, to be performed in suitable sequence, of:

(a) providing a plastically deformable plate, for instance of a plastic or a metal such as copper or aluminium;

(b) providing at least one metal strip modelled into a general wave shape, for instance of copper or aluminium, which can serve as a row of fins;

(c) plastically deforming the plate such that it acquires an edge zone with which it can be connected to a similar plate;

(d) prior to or after step (c), connecting the strip to the plastically deformable plate by means of the outermost surfaces of the wave shape directed toward the strip such that a heat-conducting wall with heat-conducting fins is created;

(e) repeating steps (a), (b), (c) and (d) a number of times to obtain a number of heat-conducting walls with fins;

(f) connecting these walls at least in twos to each other using the edge zones according to step (c) such that a chosen number of such walls is placed in mutually parallel relation; and

(g) accommodating these walls in a housing with primary and secondary inlets and outlets for the respective media.

2. Method as claimed in claim 1, wherein the plastic deformation according to step (c) takes place in cold state.

3. Method as claimed in claim 1, wherein the plate and/or the fins are provided prior to step (d) with an adhesive layer, and that step (d) is performed by pressing the plate and the fins against each other at least at the position of the contact surfaces, optionally while heating.

4. Method as claimed in claim 3, wherein the adhesive layer substantially covers the plate and/or the fins completely and protects them against corrosion.

5. Method as claimed in claim 4, wherein the adhesive layer is applied as foil.

6. Method as claimed in claim 4, wherein the adhesive layer is formed together with the plate by co-extrusion into a laminated co-extrudate.

7. Method as claimed in claim 4, wherein the plate and/or the fins consist of a material to which the adhesive layer adheres with difficulty, for instance aluminium, and that the part of the adhesive layer directed to the aluminium is adhered thereto via a layer of primer.

8. Method as claimed in claim 7, wherein the primer has a chosen colour, pattern and/or texture, and that the adhesive layer is transparent.

9. Method as claimed in claim 4, wherein the primer and/or the coating contain silver, such that the adhesive layer has an anti-microbial action.

10. Method as claimed in claim 1, wherein finished plates with fins are adhered to each other in alternate pairs using edge zones, and a number of thus formed pairs are stacked onto each other prior to step (g).

11. Method as claimed in claims 3 and 10, wherein adhesion takes place by providing the plates in advance with the adhesive layer and pressing the edge zones against each other, optionally while heating.

12. Method as claimed in claim 11, wherein the plates are adhered to each other via a sheet which is placed beforehand therebetween and which is provided on both sides with an adhesive layer, and that the respective edge zones directed toward each other and preferably also the respective outer surfaces of the fins directed toward each other are thus adhered to each other by being pressed together, optionally while applying heat, for instance by feeding through hot air.

13. Heat exchanger obtained by applying a method as claimed in any of the foregoing claims.

14. Heat exchanger as claimed in claim 13, characterized in that

the walls are arranged in at least one group of at least two walls, wherein a group is formed from an integral sheet which comprises at least a layer of plastic and which is brought into a preselected form by pressing, thermo-forming, vacuum-forming, injection moulding or other modelling process and is provided with a hinge zone in the transition between two adjacent walls, wherein by folding about the hinge zone the two walls are then placed into substantially mutually parallel relation and at a chosen mutual distance, and are held by positioning means.

15. Heat exchanger as claimed in claim 14, characterized in that

a hinge zone consists of two hinge lines which are located at the said mutual distance.

16. Heat exchanger as claimed in claim 14, characterized in that

a hinge zone comprises two parts which form part of the respective walls and are folded at substantially 90°, which parts are mutually connected by a hinge line.

17. Heat exchanger as claimed in claim 14, characterized in that

the sheet is embodied as a laminate, comprising a metal inner layer which is coated on both sides with respective plastic outer layers.

18. Heat exchanger as claimed in claim 15, characterized in that

heat-conducting fins or surface area-increasing means are arranged, prior to folding, on both sides of the sheet in the zones of the walls in order to increase the heat transfer between the two media.

19. Heat exchanger as claimed in claim 17, characterized in that

the fins in adjacent layers co-act with each other mechanically such that all fins also serve as structural elements in the manner of a packet.

20. Heat exchanger as claimed in claim 17, characterized in that

the sheet is provided in the zone of the wall with a perforation, to the edges of which the heat-conducting wall parts carrying the fins are sealingly adhered.

21. Heat exchanger as claimed in claim 14, characterized in that

the inlet zone and/or the outlet zone of a channel is provided with a deflection dam which deflects the relevant medium flow to the inlet or from the outlet.

22. Heat exchanger as claimed in claim 17, characterized in that

at least the fins in the secondary medium through-low circuit are provided with a hydrophilic and porous or fibrous coating, consisting for instance of a microporous Portland cement, which layer is kept wet by watering means forming part of the heat exchanger such that, through evaporation therefrom by the secondary medium, respectively the layer, the secondary fins, the wall, the primary fins and finally the primary medium are cooled, which layer has a small thickness such that in wet state it has a sufficiently low heat resistance such that the heat exchanger can operate as dewpoint cooler.

23. Heat exchanger as claimed in claim 14, characterized in that

the sheet is embodied as a laminate, comprising a metal inner layer which is coated on both sides with plastic outer layers.

24. Heat exchanger as claimed in claim 14, characterized in that

two sheets are each folded into the form of a rectangular wave shape, wherein the two wave shapes have equal pitch, and are positioned mutually interlaced with a relative longitudinal orientation of 90°.

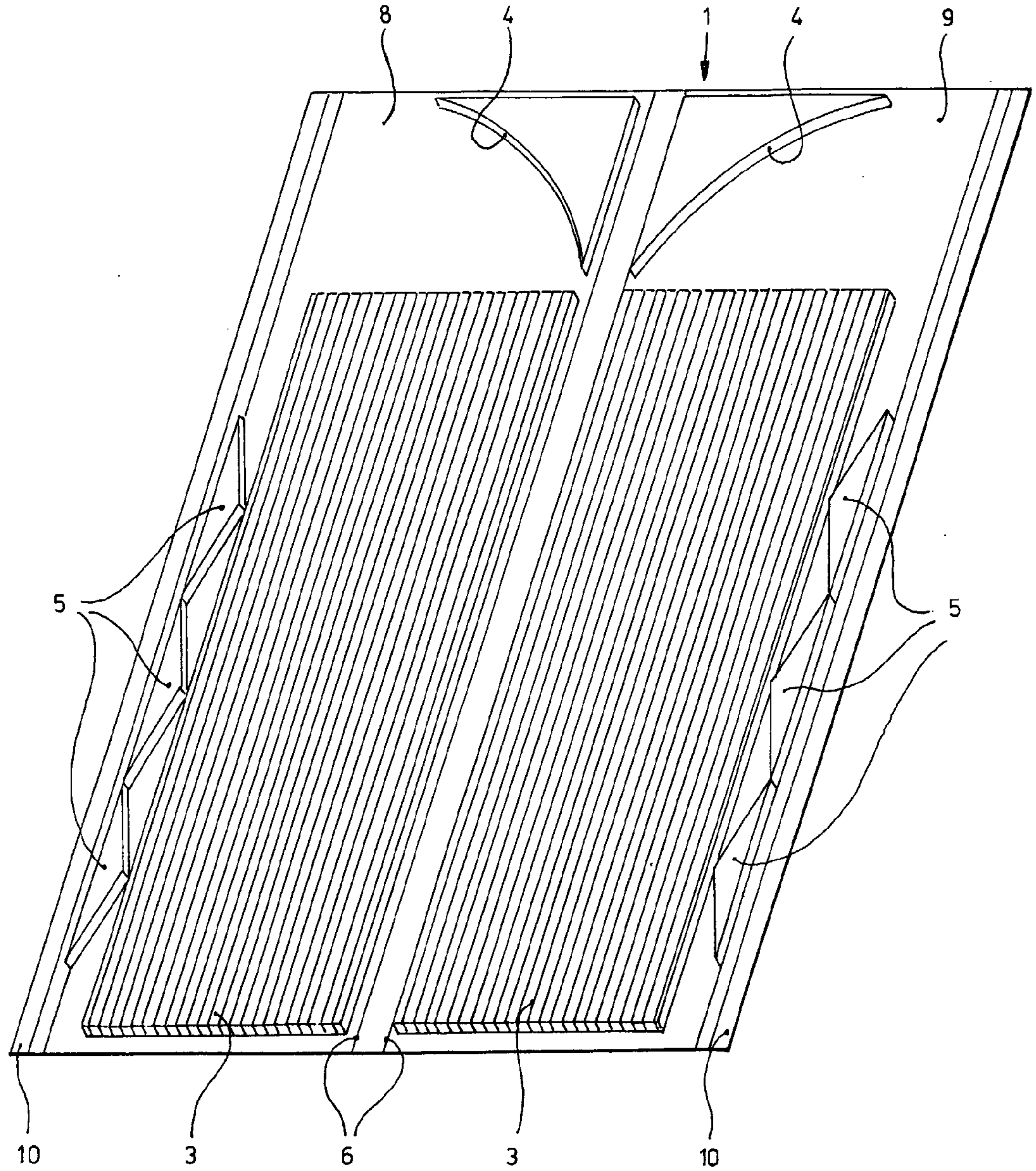

fig.1a

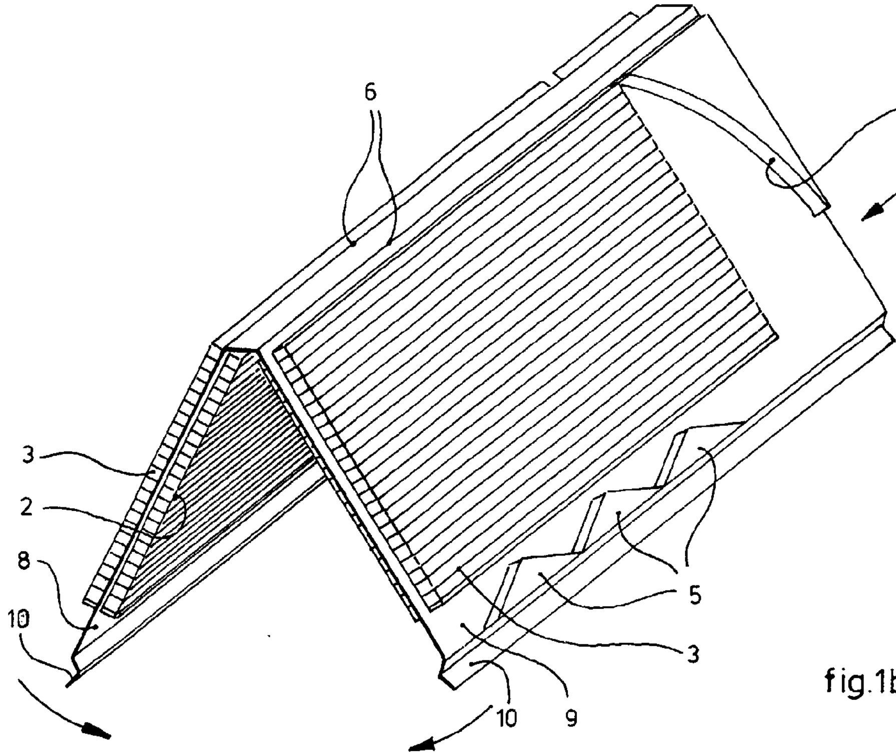

fig.1b

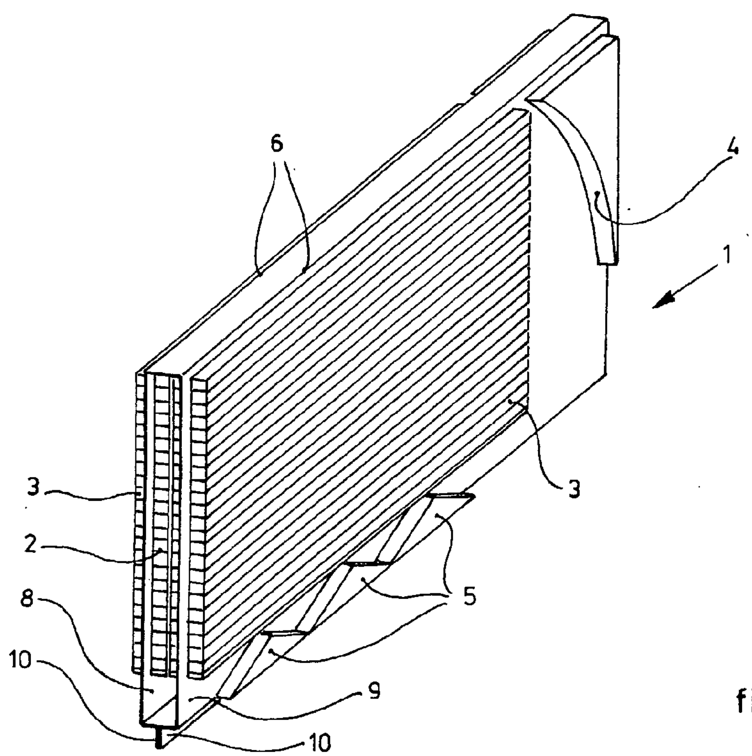

fig.1c

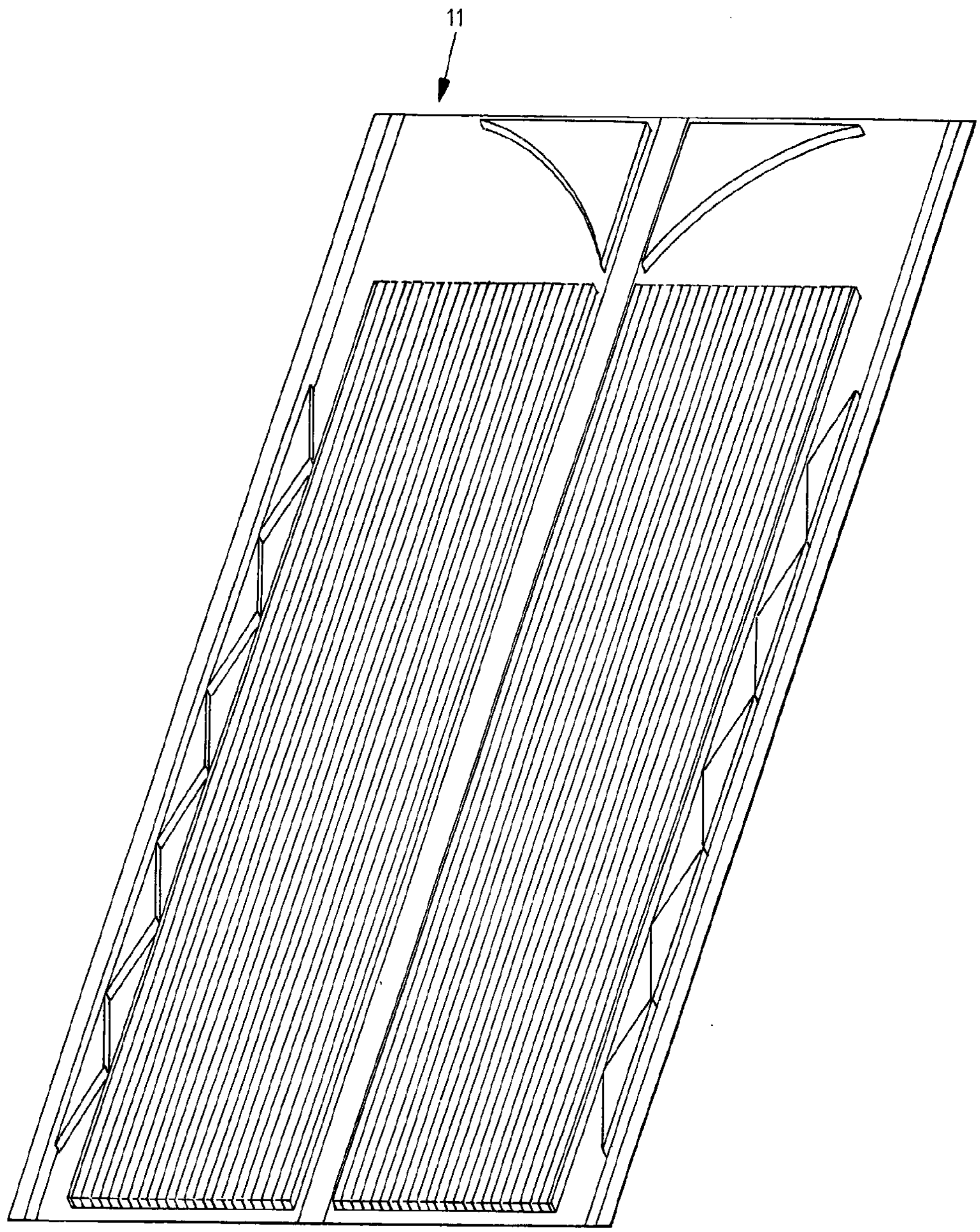

fig.2a

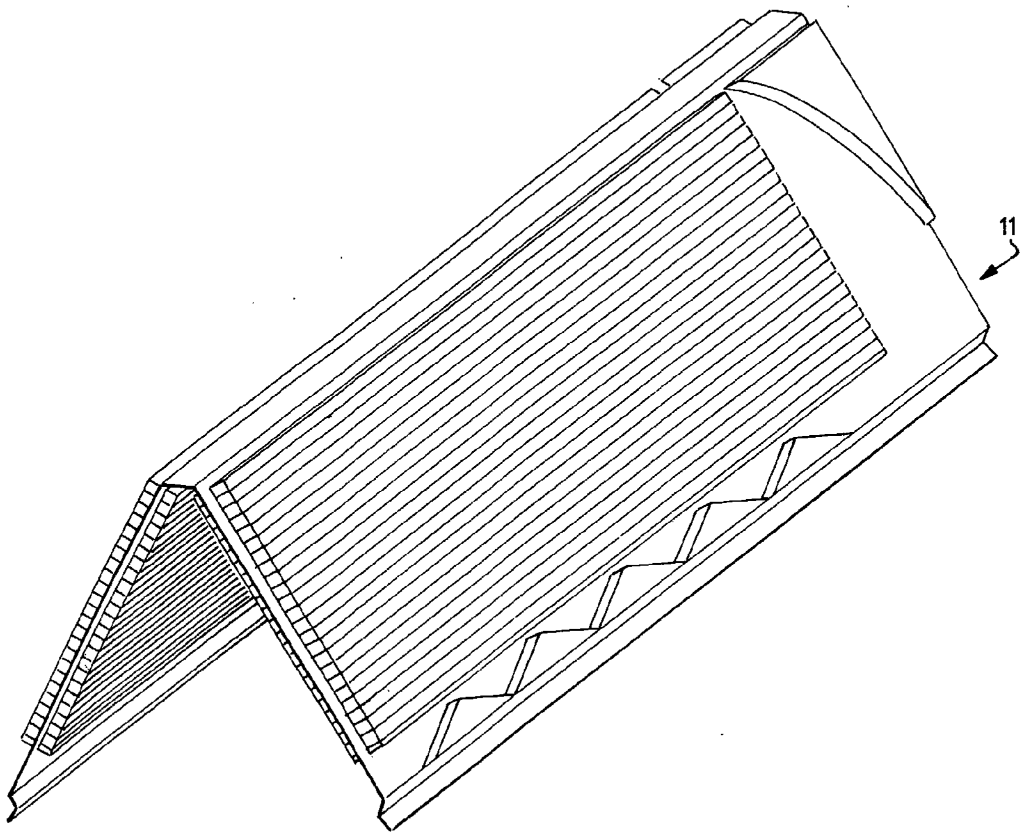

fig. 2b

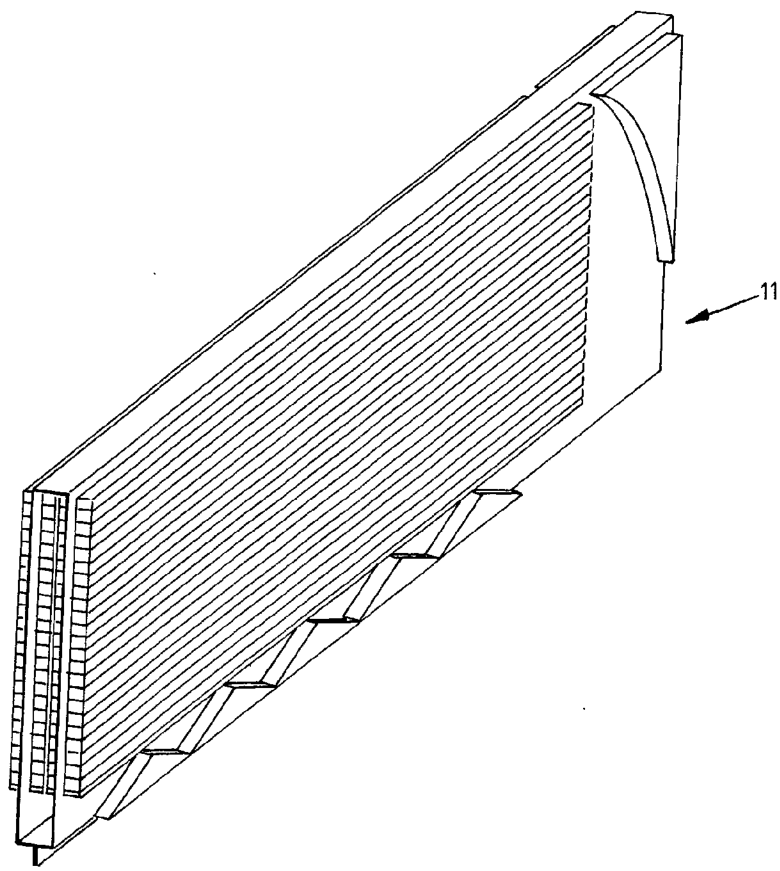

fig. 2c

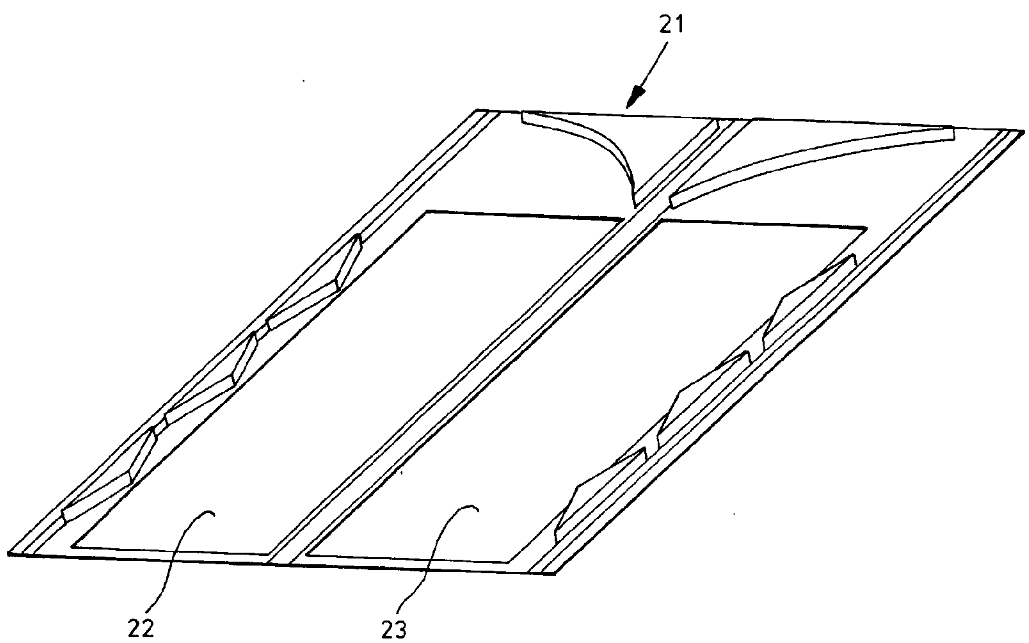

fig.3a

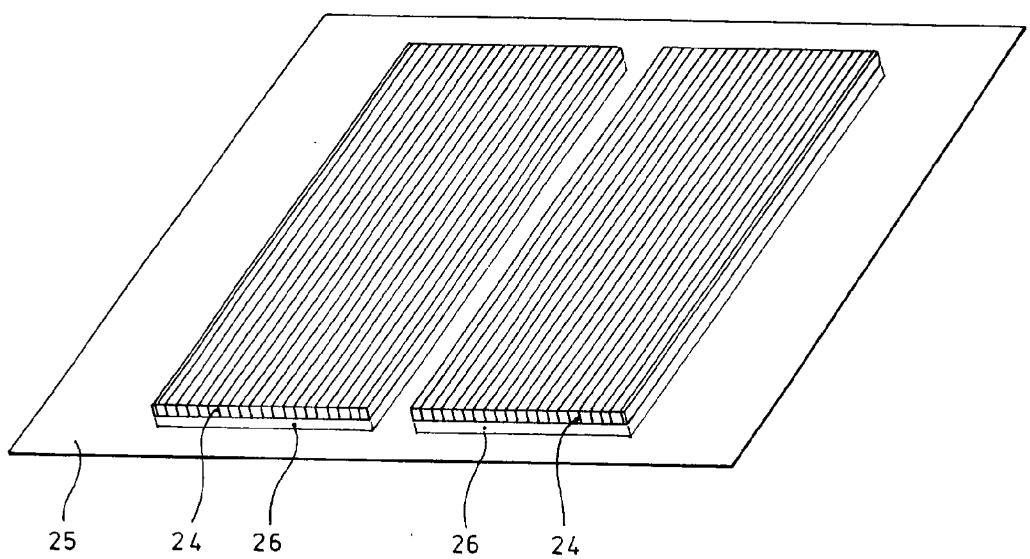

fig. 3b

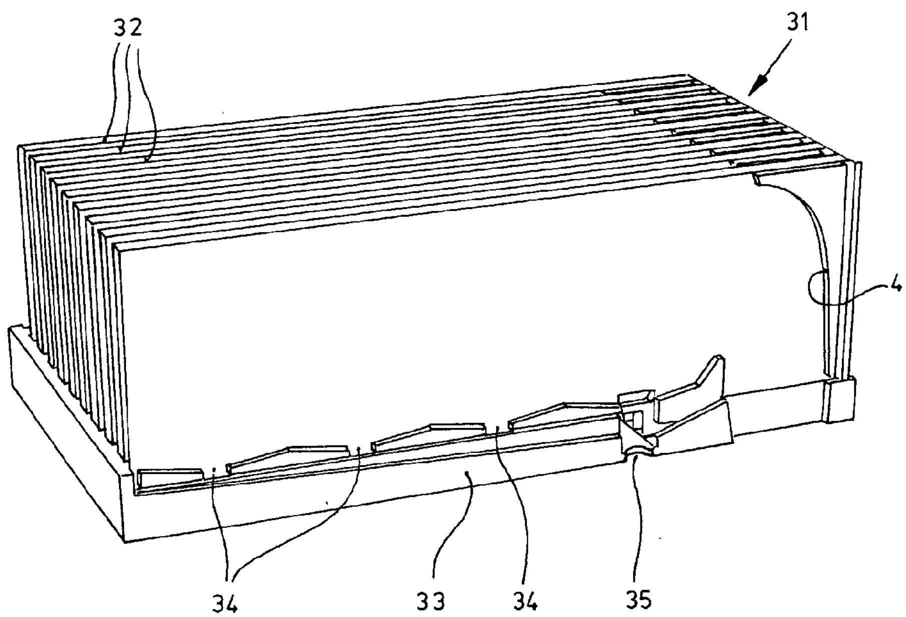

fig.4

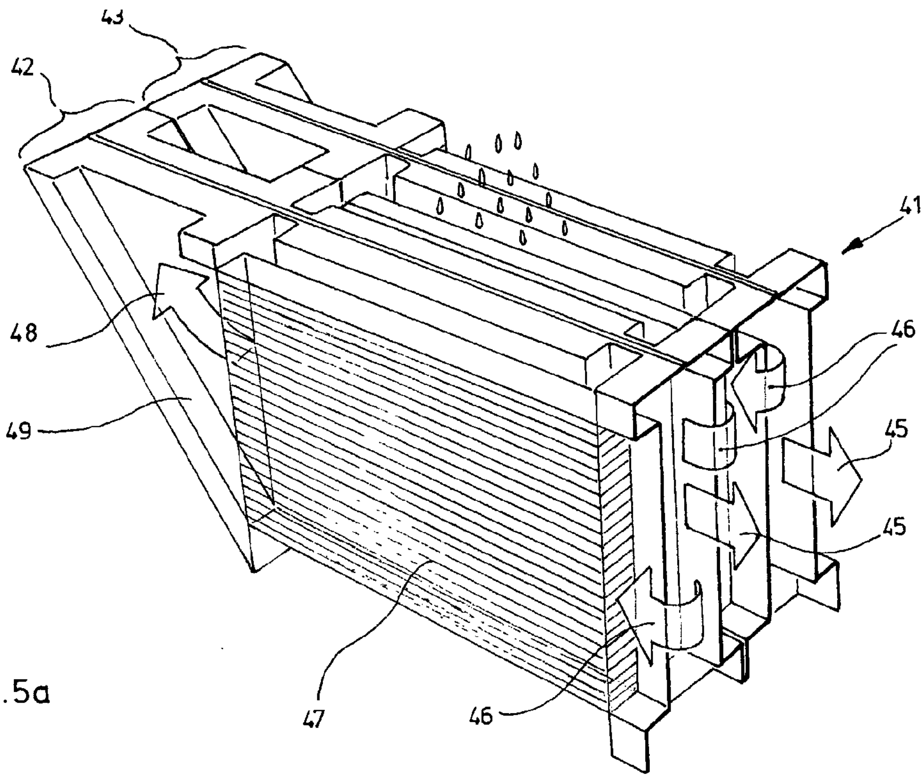

fig.5a

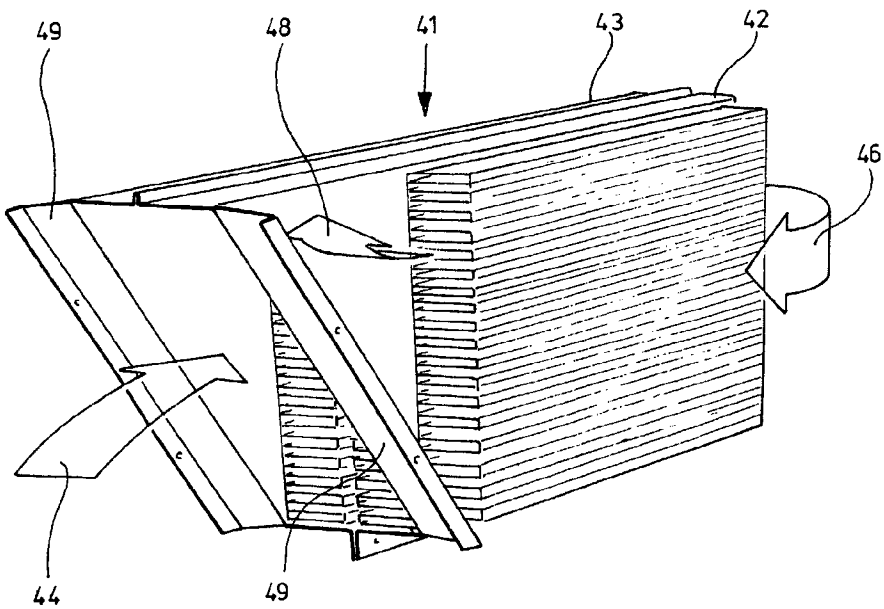

fig.5b

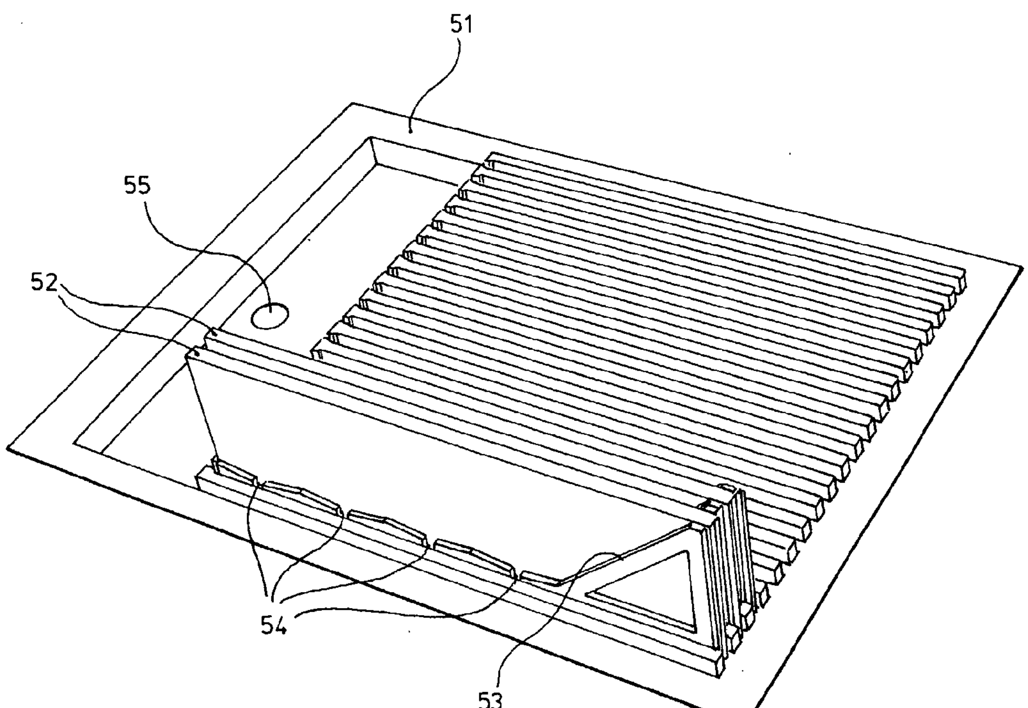

fig.6

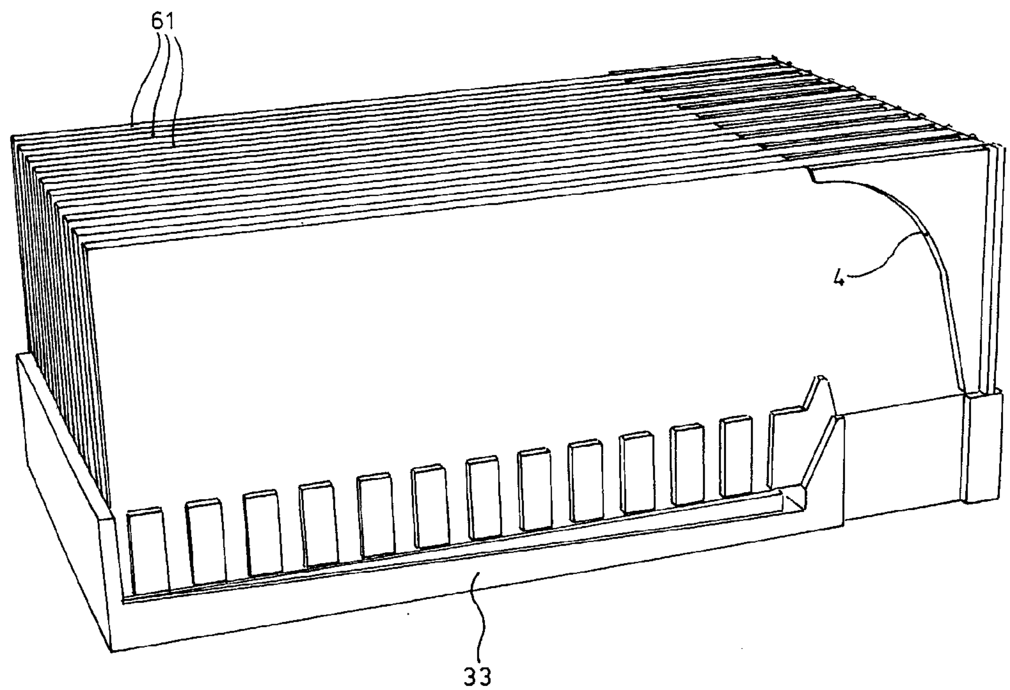

fig.7

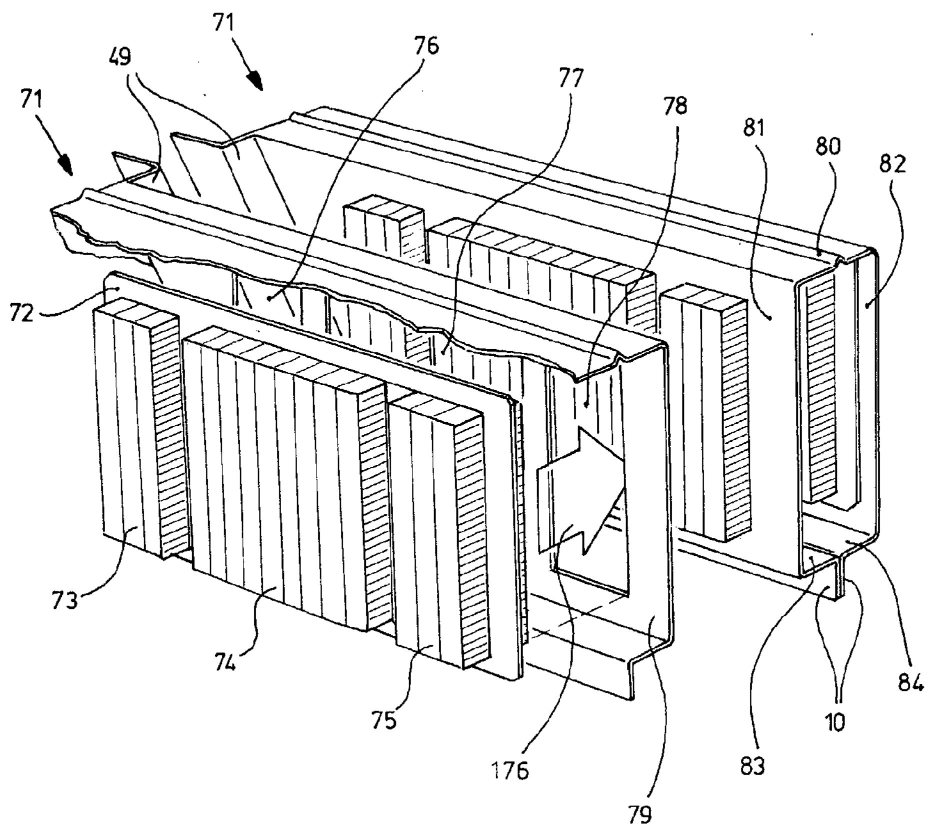

fig.8

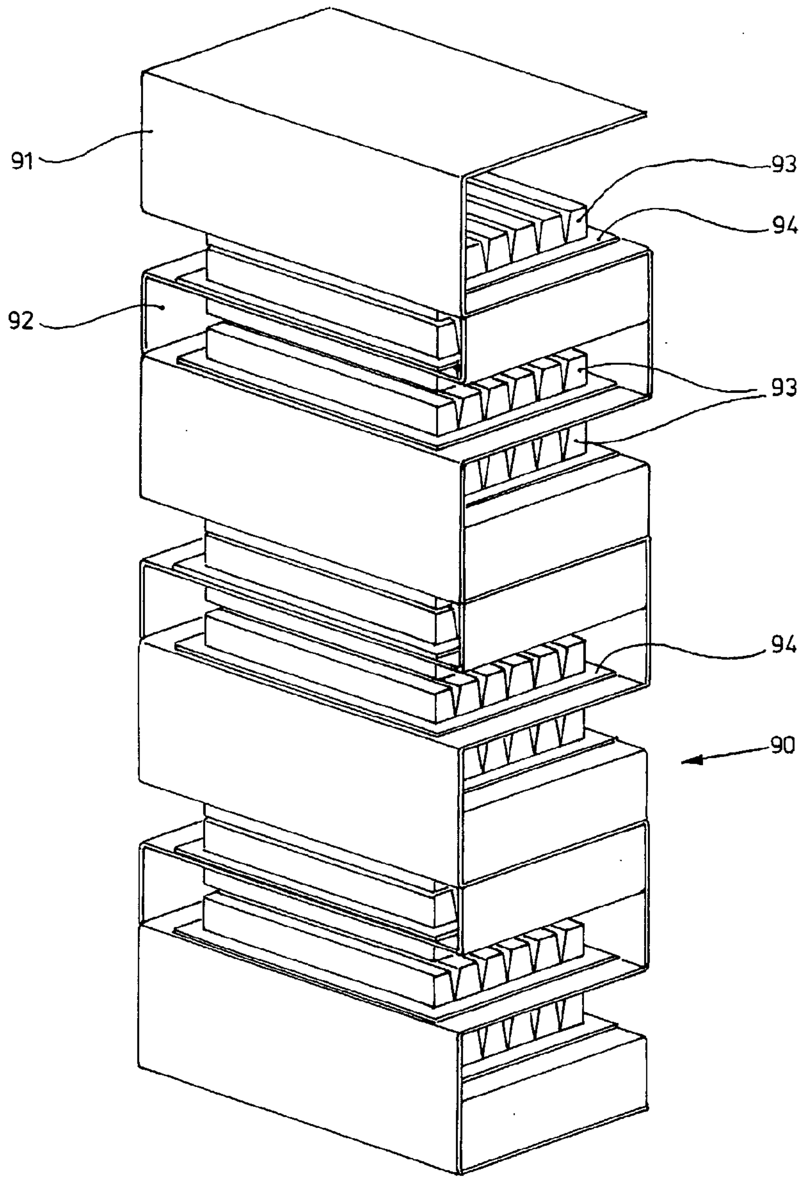

fig.9

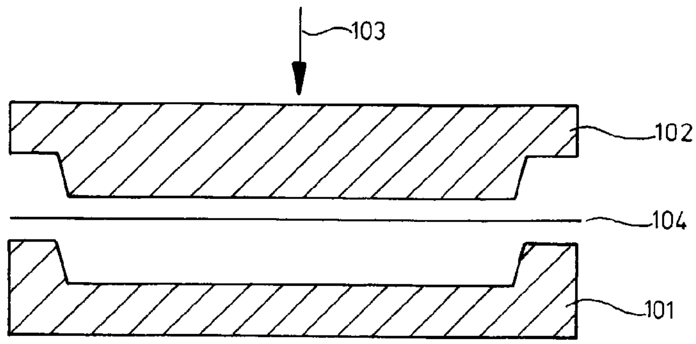

fig.10a

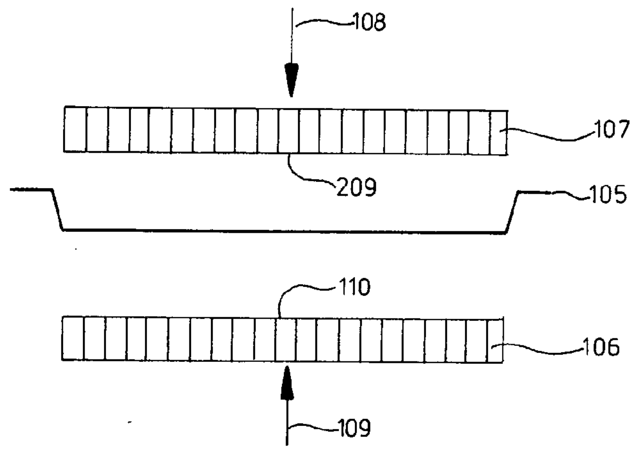

fig.10b

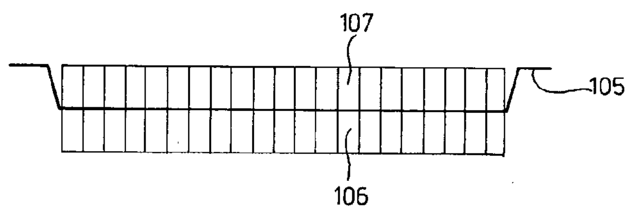

fig.10c

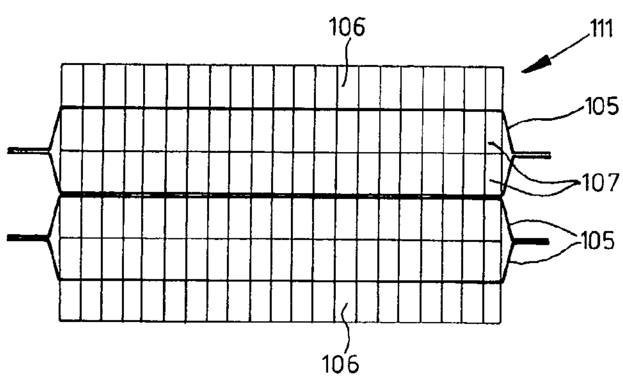

fig.10d

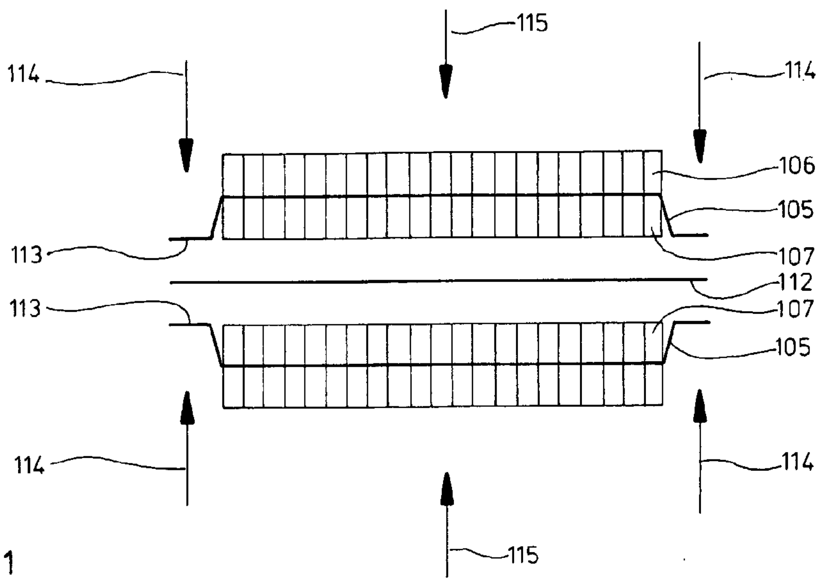

fig.11

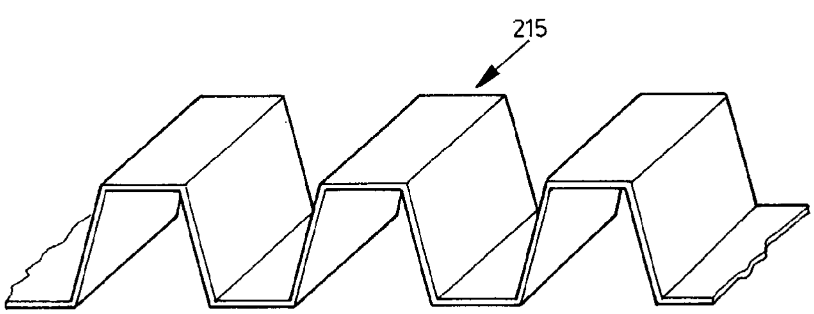

fig.12

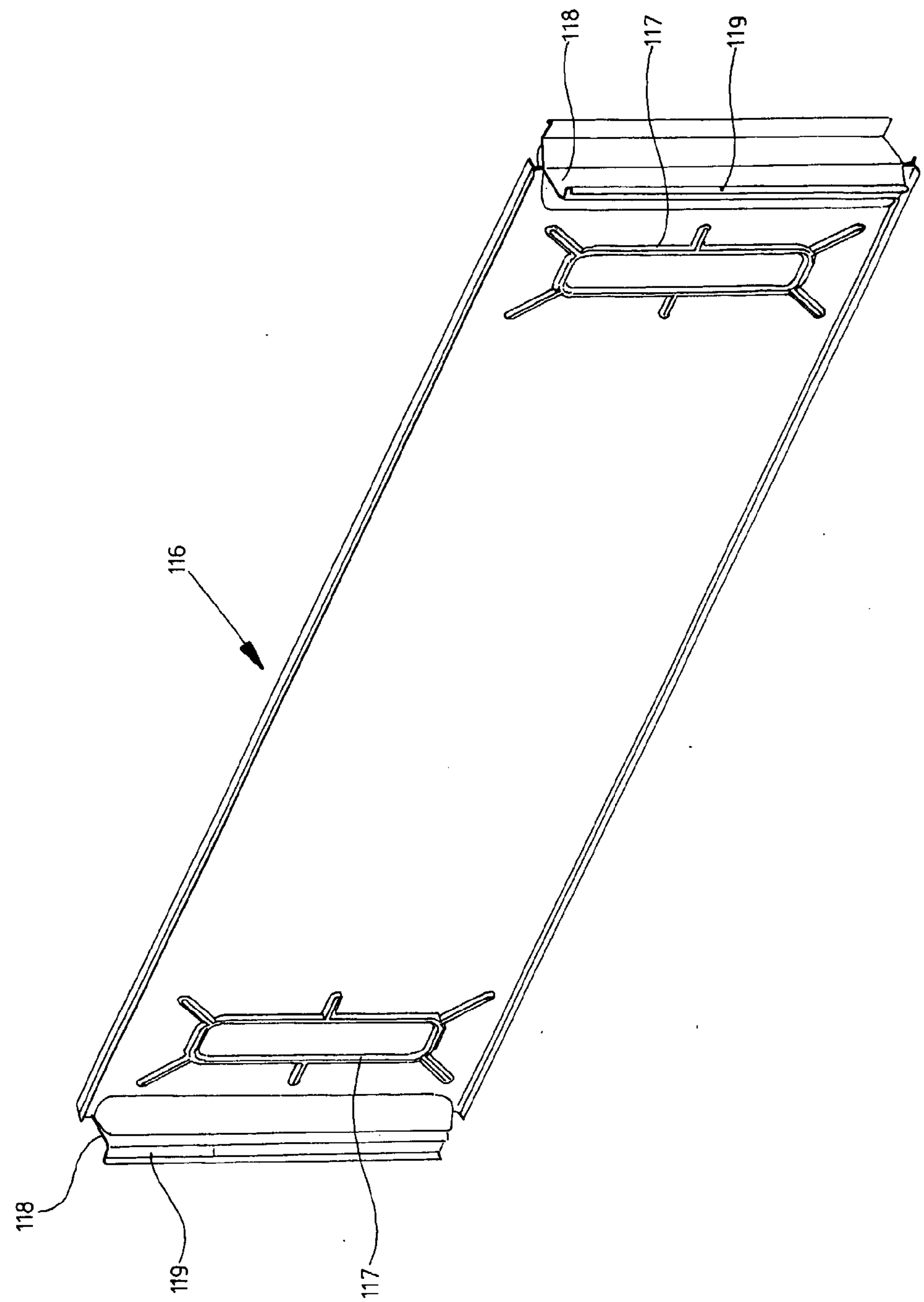

fig.13

INTERNATIONAL SEARCH REPORT

PCT/NL 03/00727

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 F28D9/00 F28F21/06 F24F5/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 F28D F28F F24F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 460 388 A (OKAMOTO KUNIO ET AL) 17 July 1984 (1984-07-17) column 4, line 18 -column 6, line 19; figure 29	1,2,10, 13,14
Y		3,11
Y	PATENT ABSTRACTS OF JAPAN vol. 008, no. 234 (M-334), 26 October 1984 (1984-10-26) -& JP 59 113942 A (SANYO DENKI KK), 30 June 1984 (1984-06-30) abstract	3,11
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Y		14-16

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 February 2004	17/02/2004

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Beltzung, F

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A	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 11, 29 November 1996 (1996-11-29) -& JP 08 178576 A (DAIKIN IND LTD), 12 July 1996 (1996-07-12) abstract ---	1,13-16
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A	US 4 407 359 A (CAUNES PIERRE ET AL) 4 October 1983 (1983-10-04) column 5, line 44 - line 68; figures 1-5 ---	1-5
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